



UTILITY PATENT APPLICATION TRANSMITTAL

(for new applications under 37 C.F.R. § 1.53(b))

Customer Number: 000201
 Attorney Docket Number: F3238(C)
 Applicant: Bastiaan Hendrik BAKKER; Peterus Martinus Maria BONGERS;
 Wei WANG-NOLAN;
 For: PROCESS AND APPARATUS FOR PRODUCTION OF A FROZEN
 FOOD PRODUCT
 Express Mail Label No.: EK417757342US
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To: Assistant Commissioner for Patents
 Box: Patent Application
 Washington, D.C. 20231

APPLICATION ELEMENTS


1. ☒ Fee Calculation (Box 13) and Authorization (Triplicate copies of this form are enclosed)
2. ☒ Specification and Claims (11) Total Pages
3. ☐ Formal or Informal Drawings () Total Sheets
4. ☒ Unexecuted Declaration
5. ☐ Nucleotide and/or Amino Acid Sequence Submission (if applicable, all necessary)
 - a. ☐ Computer Readable Copy
 - b. ☐ Paper copy (identical to computer copy)
 - c. ☐ Statement verifying identify of above copies.

ACCOMPANYING APPLICATION PARTS

6. ☐ Information Disclosure Statement (IDS)/PTO-1449
7. ☐ Copies of IDS citations
8. ☒ Preliminary Amendment
9. ☒ Two (2) Return Receipt Postcards
10. ☐ Certified Copy of Priority Document
11. ☒ The benefit under 35 U.S.C. § 119 is claimed of the filing of United Kingdom Application No. 9912629.4, filed May 28, 1999.
12. ☐ Other:
13. ☒ The FILING FEE (including any claims introduced or cancelled by Preliminary Amendment) is calculated below:

CLAIMS				
FOR	NUMBER FILED	NUMBER EXTRA	RATE	BASIC FEE \$690.00
Total Claims	14 - 20		X \$ 18.00	
Independent Claims	3 - 3		X \$ 78.00	
Multiple Claims	<u>Yes</u> <u>No</u>		X \$ 260.00	
TOTAL FILING FEE . . .				\$690.00

- [illegible]


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PATENT
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F3238(C)

Express Mail Label No.: EK417757342US

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Bakker et al.

Deposited: May 24, 2000

For: PROCESS AND APPARATUS FOR PRODUCTION
OF A FROZEN FOOD PRODUCT

Edgewater, New Jersey 07020
May 24, 2000

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

With regard to the above-identified application filed concurrently
herewith, please amend the following:

In the Claims:

Claim 7, line 1, please replace the words "any preceding claim" with
-- claim 1 --.

_ Claim 12, line 1, please replace the words "any preceding claim 8 to
11" with --claim 8--.

Respectfully submitted,


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Process and apparatus for production of a frozen food
product

5 Technical field of the invention

The present invention relates to a process and an apparatus for the production of a frozen food product and more particularly an ice cream.

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Background of the invention

Screw extruders such as single and twin screw extruders have been widely used and for a long time in the food
15 industry, for example in the production of cereal based products. More recently, it has also been proposed to use single or twin screw extruders in the freezing of ice cream.

EP713650 discloses a process and an apparatus for extruding
20 aerated frozen products wherein a twin screw extruder is used. The characteristic of the screws in the extruder is that they have a length over diameter ratio of between 30 and 60. It is not disclosed whether the diameter which is referred to is the diameter of the core of the screw or the
25 diameter of the core of the screw plus its pitch. EP0808577 discloses a similar process and apparatus but whilst uses a single screw extruder having the same geometry.

EP561118 discloses a process and an apparatus for
30 manufacturing frozen edible foams such as ice cream wherein a twin screw extruder is used. The geometry of the screw is defined by a (channel depth/channel width) ratio of approximately 0.1 and a pitch angle of between 22 and 30 degrees.

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WO97/26800 discloses a process and an apparatus for manufacturing frozen edible foams such as ice cream wherein a single screw extruder is used. The geometry of the screw is defined by a (length of the screw/ inner diameter of the extruder barrel) ratio of between 5 and 10 a (pitch/external screw diameter) ratio of 1 to 2 and a (external diameter of the screw/inner diameter of the screw) of 1.1 to 1.4. According to the drawings, the screw has a single thread start.

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One of the big problems faced when using an extruder for the manufacture of ice cream is that a temperature as low as possible is required while keeping an acceptable flow. Now, the lower the temperature the bigger the flow resistance which by generating frictions re-heats the product which is being cooled and limits the temperature which is thus achieved. There is therefore a need for optimising the geometry of the extruder in such a way that the increase in friction which is generated when the product is cooled is minimised in order to reach a temperature as low as possible.

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It has now been found that it is possible to dramatically increase the performance of an extruder when used in the manufacturing of ice cream by;

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- . operating with a pitch angle which is outside what has been used up to now in the manufacturing of ice cream,
- . operating with screws which have more than one thread start whereas up to now screws with only one thread start screws have been disclosed,
- . operating with extruders which are much shorter than what has been used up to now.

30

35

Tests and Definitions1. Screw parameters

- 5 An extruder screw is defined by different parameters which need accurate definitions. In order to help in the definition of such parameters, reference is made to Fig.1 which discloses a typical screw fitted in a single screw extruder. Such an extruder is, for example, described in
10 Engineering principles of plasticating extrusion - Zehev Tadmor - Krieger Publishing Company - 1978 - pages 39 to 45.

Screw length : LT (length of the screw which is in contact with the barrel)

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Pitch length: Sp (axial distance of a full turn (screw lead))

- Thread starts: A screw can have more than one helix, in the
20 rest of the description, each helix is called a thread start and the number of thread starts is 'n'. On Fig.1, the screw which is represented has two thread starts.

- Channel depth: H (the distance between the root of the screw
25 and the inner surface of the barrel less the radial clearance between the crest of the screw and the inner surface of the barrel)

- Screw diameter De: Diameter of the barrel less the distance
30 between the root of the screw and the inner surface of the barrel.

Pitch angle: $\text{Arctg}(Sp/\pi.De)$

Summary of the invention

Preferably the extruder comprises cooling means, more preferably, the cooling means are constituted by a cooling circuit wherein a cooling liquid is circulated. Even more
15 preferably the cooling liquid is ammonia or nitrogen.

Preferably the (H/wc) ratio is between is less than 0.2, more preferably more than 0.1. It has been found that at low H/wc ratio, the heat exchange (cooling) improves but the thermal dissipation (heating) due to friction increases. Conversely at higher H/wc ratio, the heat exchange decreases but the thermal dissipation decreases even more, therefore, operating at high H/wc ratio is preferred. There is nevertheless a limit in the H/wc ratio which can be used since, above a certain limit, the product is no longer thermally homogeneous and cold and warm zones start appearing which do not mix any more.

Preferably also, the screw comprises between 3 and 4 thread starts and the cooling liquid is ammonia.

Preferably also the screw has a LT/De ratio of between 2 and 10, more preferably between 2 and 5, even more preferably between 2 and 4. It has been found that, and contrary to what is suggested by the prior art, not only there is no need for going for long screws but it is effectively a waste of energy. If the screw is too long, the heat dissipation due to the friction caused by the increase in viscosity generated by the cooling tends to equate the cooling effect and the two phenomenon (cooling and heat dissipation) equilibrate and there is no cooling taking place at the end of the screw. Nevertheless, the friction existing at the end of the screw, where no cooling takes place, requires additional torque to keep the screw rotating for no benefit to the process or the end product.

Preferably also, the extruder is a single screw extruder.

It is a second object of the invention to provide extruder comprising an extruding screw characterised by a pitch angle of between 28 and 45 degree, preferably between 32 and 42, and a LT/De ratio of between 2 and 10, preferably 2 and 5, more preferably 2 and 4.

It is a third object of the present invention to provide a process for the manufacturing of frozen food product, wherein a food composition is mixed, aerated and cooled down to a temperature of between -4°C and -7°C and then processed in an extruder for further cooling down to a temperature of between -12° and -20°, characterised in that the extruder comprises an extruding screw having 2 to 5 thread starts and a pitch angle of between 28 and 45 degrees, preferably between 32 and 42 degrees, and further comprises cooling

means, the cooling means being preferably constituted by a cooling circuit wherein a cooling liquid is circulated.

Preferably the cooling liquid is selected within the group
5 consisting of ammonia or nitrogen. More preferably, the screw comprises between 3 and 4 thread starts and the cooling liquid is ammonia.

Preferably also the screw has a LT/De ratio of between 2 and
10 10, more preferably between 2 and 5, even more preferably between 2 and 4.

Preferably also, the extruder is a single screw extruder.

15 It is a fourth object of the invention to provide a process for the manufacturing of frozen food product, wherein a food composition is mixed, aerated and cooled down to a temperature of between -4° and -7° and then processed in an extruder for further cooling down to a temperature of
20 between -12° and -20° , characterised in that the extruder comprises cooling means, the cooling means being preferably constituted by a cooling circuit wherein a cooling liquid is circulated and further comprises an extruding screw having a pitch angle of between 28 and 45 degrees, preferably between
25 32 and 42 degrees, and a LT/De ratio of between 2 and 10, preferably between 2 and 5, more preferably between 2 and 4.

Preferably the cooling liquid is selected within the group
30 consisting of ammonia or nitrogen. Preferably also the screw comprises between 3 and 4 thread starts and the cooling liquid is ammonia.

Detailed description of the invention

The present invention will be further described in the following examples and by reference to the drawing wherein;

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. Figure 1 represents a schematic view of an extruder comprising an extruding screw.

An ice cream premix having the following composition;

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Total fat: 8.4%

Stabiliser emulsifier: 0.56%

Added Sugars: 16.8%

Total protein : 3.5%

Total solids: 34.9%

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Of which Milk solids (non fat): 9.55%

Water: the rest

was aerated up to an overrun of 100% and cooled down to a temperature of -4.5°C using conventional means for subsequent processing.

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The cooled product obtained was then conveyed to a single screw extruder according to the invention for subsequent extrusion. The product was extruded at 500 litre ice cream per hour in a single screw extruder cooled with ammonia, the screw having a diameter of 200mm.

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Various screw geometries were tested and the results are summarised in the following table.

- 8 -

Pitch angle (degree)	Channel depth (H) (mm)	Number of Thread Starts	H/Wc	Ice cream temperature (°C)	Torque (Nm)	Ammonia temperature (°C)	Rotation speed (rpm)	Extruder Inlet Pressure (bar)
12	15	2	0.28	-11.6	1572	-30.8	29.0	8
14	17	3	0.43	-11.6	1486	-30.5	30.2	8
19	10	4	0.25	-12.1	1597	-27.2	22.6	8
28	8	4	0.12	-11.9	1629	-27.5	18.8	8
35	8	4	0.10	-12.9	1602	-25.9	14.6	8
40	11	4	0.12	-14.1	1600	-26.8	12.4	8
40	5	6	0.09	-12.2	1609	-25.0	21.0	10
40	7	6	0.12	-12.7	1604	-26.1	20.6	10
40	9.8	6	0.17	-13.7	1602	-26.2	13.2	10
40	11	6	0.19	-13.1	1600	-26.1	12.4	10
40	11	3	0.09	-13.6	1601	-28.2	12.1	10
40	15.5	3	0.12	-13.4	1597	-28.0	10.4	10
40	18	3	0.14	-13.8	1602	-27.6	9.7	10

Claims

1. Extruder comprising an extruding screw, said extruding
5 screw being characterised by between 2 and 6 thread
starts and a pitch angle of between 28 and 45 degrees,
preferably between 32 and 42 degrees.
2. Extruder according to claim 1 comprising cooling means,
10 the cooling means being preferably constituted by a
cooling circuit wherein a cooling liquid is circulated.
3. Extruder according to claim 2 wherein cooling liquid is
15 selected within the group consisting of ammonia or
nitrogen.
4. Extruder according to claim 3 wherein the screw
comprises between 3 and 4 thread starts and the cooling
20 liquid is ammonia.
5. Extruder according to claim 1 wherein the screw LT/De
ratio of between 2 and 10, preferably between 2 and 5,
more preferably between 2 and 4.
- 25 6. Extruder according to claim 1 wherein the H/wc ratio is
under 0.2, preferably over 0.1.
7. Extruder according to any preceding claim wherein the
30 extruder is a single screw extruder.
8. Extruder comprising an extruding screw characterised by
a pitch angle of between 28 and 45 degrees, preferably
32 and 42 degrees, and a LT/De ratio of between 2
and 10, preferably between 2 and 5, more preferably
35 between 2 and 4.

9. Extruder according to claim 8 comprising cooling means, the cooling means being preferably constituted by a cooling circuit wherein a cooling liquid is circulated.

5 10. Extruder according to claim 9 wherein the cooling liquid is selected within the group consisting of ammonia or nitrogen.

11. Extruder according to claim 10 wherein the screw
10 comprises between 3 and 4 thread starts and the cooling
liquid is ammonia.

12. Extruder according to any preceding claim 8 to 11 wherein the extruder is a single screw extruder.

13. Process for the manufacturing of frozen food product, wherein a food composition is mixed, aerated and cooled down to a temperature of between -4° and -7° and then processed in an extruder for further cooling down to a temperature of between -12° and -20° , characterised in that the extruder comprises cooling means, the cooling means being preferably constituted by a cooling circuit wherein a cooling liquid is circulated and further comprises an extruding screw having a pitch angle of between 28 and 45 degrees, preferably between 32 and 42 degrees

14. Process according to claim 13 wherein the screw has a
LT/De ratio of between and 2 and 10, preferably between
2 and 5, more preferably between 2 and 4.

Abstract

The performance of an extruder when used in the manufacturing of ice cream by operating with a pitch angle
5 of between 28 and 45 degrees with screws which have more than one thread start.

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

PROCESS AND APPARATUS FOR PRODUCTION OF A FROZEN FOOD PRODUCT

the specification of which (check only one item below):

☒ is attached hereto.

☐ was filed as United States application Serial No. _____ on _____
and was amended on _____ (if applicable)

☐ was filed as PCT International application _____ on _____
and was amended under PCT Article 19 on _____ (if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, § 1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code § 119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. 119:

COUNTRY (if PCT indicate PCT)	APPLICATION NUMBER	DATE OF FILING (day,month,year)	PRIORITY CLAIMED UNDER 35 USC 119
UNITED KINGDOM	9912629.4	28 TH May 1999	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO
			<input type="checkbox"/> YES <input type="checkbox"/> NO
			<input type="checkbox"/> YES <input type="checkbox"/> NO

I hereby claim the benefit under Title 35, United States Code § 120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that /those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code § 112. I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations § 1.56 (a) which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application.

PRIOR U.S. APPLICATIONS OR PCT INTERNATIONAL APPLICATIONS DESIGNATING THE U.S. FOR BENEFIT UNDER 35 U.S.C. 120.

U.S. APPLICATION(S)		STATUS (CHECK ONE)		
U.S. APPLICATION NUMBER	U.S Filing Date	PATENTED	PENDING	ABANDONED
PCT APPLICATIONS DESIGNATING THE U.S.				
PCT APPLICATION NUMBER	PCT Filing Date	U.S Serial Numbers Assigned (if any)		

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (continued)
(includes Reference to PCT International Applications)

ATTORNEY DOCKET NUMBER
F3238(C)

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

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201

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that wilful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such wilful false statements may jeopardize the validity of the application or any patent issuing thereon.

Signature of Inventor 201	Signature of Inventor 202	Signature of Inventor 203
Date	Date	Date